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**SCIENTIFIC CRITERIA DOCUMENT FOR  
THE DEVELOPMENT OF AN INTERIM  
PROVINCIAL WATER QUALITY  
OBJECTIVE FOR ANILINE**

**APRIL 1996**

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SCIENTIFIC CRITERIA  
DOCUMENT FOR THE  
DEVELOPMENT OF AN INTERIM  
PROVINCIAL WATER QUALITY

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**SCIENTIFIC CRITERIA DOCUMENT FOR THE DEVELOPMENT OF AN  
INTERIM PROVINCIAL WATER QUALITY OBJECTIVE  
FOR ANILINE**

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The public was notified of the proposed Interim Provincial Water Quality Objective for aniline through the Electronic Registry and was given the opportunity to comment in accordance with the Environmental Bill of Rights.

## PREFACE

The Ontario Ministry of Environment and Energy (MOEE) develops Provincial Water Quality Objectives for those substances deemed to be of environmental concern in Ontario as determined through a screening process which considered persistence, potential to bioaccumulate, acute and chronic toxicity, and potential presence in the aquatic environment. Alternatively, Ministry staff who have a direct responsibility for managing possible effects of contaminants may request an evaluation.

Provincial Water Quality Objectives (PWQOs) and Interim Objectives are numeric or narrative criteria intended to protect all life stages of aquatic organisms for indefinite exposures and/or they are intended to protect recreational uses of water. Objectives do not take into account analytical detection or quantification limits, treatability or removal potential, socio-economic factors, natural background concentrations, or potential transport of contaminants among air, water and soil. They represent a desirable water quality for the protection of designated uses of surface waters in Ontario.

The process for deriving these criteria is detailed in Ontario's Water Quality Objective Development Process (1992) and is available from the ministry's Public Information Centre (Tel. (416) 323-4321 or 1-800-565-4923) or Standards Development Branch (Tel: (416) 323-5095), 135 St. Clair Avenue, Toronto, Ontario M4V 1P5. The scientific literature is reviewed for all of the following areas: aquatic toxicity, bioaccumulation, mutagenicity and aesthetic considerations. The final criterion is based on the lowest effect reported for any of these. Where numeric criteria are set to protect aquatic life, the number is derived by dividing the lowest adverse effect concentration by a safety factor for Objectives or an "uncertainty factor" for Interim Objectives. The size of the uncertainty factor reflects the quality and quantity of data available and the potential of the material to bioaccumulate.

Policies and procedures which govern the uses of PWQOs are contained in the booklet, *Water Management: Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy* (1994), which deals with all aspects of Ontario's water management policy. These policies and procedures make provision for considering such factors as natural background levels, socio-economic factors, treatability, and the waste assimilative capacity of the receiving environment in applying the PWQOs in site-specific situations. PWQOs are used to: i) classify receiving waters for water management purposes; ii) assess contaminant discharges to the aquatic environment; and iii) derive water quality-based effluent limits which may be included in Certificates of Approval which are issued to regulate effluent discharges. Where better water quality is required to protect other beneficial uses of the environment in a given location, appropriate criteria and factors, including public health considerations, are taken into account.

## EXECUTIVE SUMMARY

An Interim Provincial Water Quality Objective (PWQO) was developed for aniline for the protection of aquatic life. The physical-chemical properties, aquatic toxicity, bioaccumulation potential, taste and odour characteristics, and genotoxicity potential of aniline were considered in developing the objective.

Aniline is a clear, colourless, oily liquid that is used as an intermediate in the manufacture of polyurethanes, dyestuffs, rubber processing chemicals, pharmaceuticals, inks, photographic developers, resins, varnishes, perfumes, shoe polishes and many other organic chemicals.

Aniline may enter the environment from discharges or spills associated with its production, use, storage and transportation. There is currently no producer of aniline in Canada, although at one time Uniroyal Chemical Ltd. manufactured the chemical in Elmira, Ontario. Aniline occurs naturally in coal tar. It may be found in leachate from landfill sites or it may occur as a breakdown product of pesticides that contain nitroaromatic compounds (e.g., carbamates and ureas).

Natural processes can remove aniline from land, air and water and reduce environmental exposures. As a result, ambient levels remain low or non-detectable and there is little tendency for aniline to build up in the environment over time. Aniline has been detected in effluents from municipalities and industries, ground water, soil, air and fresh fruits and vegetables in North America. Although no data were found concerning concentrations of aniline in air, soil, sediment or biota in Ontario, aniline was detected in surface water and ground water at Elmira. The concentrations found in the Canagagigue Creek at Elmira ranged from non-detectable to 0.017 mg/L (the geometric mean was approximately 0.001 mg/L)(CRA 1994).

Aniline is highly toxic to aquatic organisms when water concentrations exceed approximately 10 mg/L during short-term exposures or reach 0.04 mg/L during long-term exposures. Reported levels of toxicity include a 7d-LC50 or median lethal concentration of 8.2 mg/L and a 96h-LC50 of 10.6 mg/L for rainbow trout (Abram and Sims 1982). In a physiological study of rainbow trout exposed to a lethal concentration of aniline (68.84 mg/L), the mean survival time was  $3.4 \pm 1.5$  hours and visible signs of intoxication were exhibited shortly after toxicant exposure (Bradbury *et al.*, 1989). Gersich and Milazzo (1990) reported the lowest observed adverse effect concentration (14-d LOAEC) of approximately 0.043 mg/L for significantly reduced growth, survival and reproduction of water flea (*Daphnia magna*).

**The Interim Provincial Water Quality Objective of 0.002 mg/L was derived by dividing the lowest observed adverse effect concentration (0.043 mg/L) by a final uncertainty factor of 20.** Since the water quality criterion for the protection of aquatic life is more stringent than both the odour protection value derived for aniline and a reported concentration not impairing fish flavour, it is recommended as the interim PWQO.



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## 1.0 INTRODUCTION

Aniline ( $C_6H_7N$ ) is a clear, colourless, oily liquid at room temperature. It is used as an intermediate in the manufacture of polyurethanes, dyestuffs, rubber processing chemicals and antioxidants, pharmaceuticals, inks, explosives, optical whitening agents, photographic developers, resins, varnishes, perfumes, shoe polishes, and many other organic chemicals (Howard 1989; Sittig 1985).

There is currently no producer of aniline in Canada, although at one time Uniroyal manufactured the chemical in Elmira, Ontario (CPI 1989). Aniline may be prepared by catalytic reduction of nitrobenzenes with hydrogen or iron filings or by catalytic reaction of chlorobenzene and aqueous ammonia (Hawley 1981).

The effects of aniline on human health have been recently reviewed (Government of Canada 1994; RTECS 1993; IRIS 1992). Limited health effects information is available regarding dermal exposures to aqueous solutions of aniline. The U.S. Environmental Protection Agency has given aniline a cancer rating of "B2" (probable human carcinogen). Human exposures to aniline are primarily in the workplace (Howard 1989). Occupational exposures to aniline, usually by inhalation or percutaneous routes of exposure, can result in methaemoglobin formation and consequent cyanosis or blue skin and respiratory distress (IRIS 1994; U.S. EPA 1985).

The purpose of this document is to develop an Interim Provincial Water Quality Objective for aniline for the protection of aquatic life. Aniline was identified a priority for objective development because it was deemed to be a substance of environmental concern in Ontario and is possibly released to the environment through industrial or commercial activities.

### 1.1 SOURCES OF ANILINE IN THE ENVIRONMENT

Aniline may enter the environment from discharges or spills associated with its production, use, storage and transportation (Government of Canada 1994; Howard 1989). Aniline occurs naturally in coal tar. It may be found in leachate from landfill sites or it may occur as a breakdown product of pesticides that contain nitroaromatic compounds (e.g., carbamates and ureas).

### 1.2 ENVIRONMENTAL FATE AND PROPERTIES

The physical and chemical properties of aniline are shown in Table 1. Based on its relatively low Henry's Law Constant, vapour pressure and log Kow (octanol/water partition coefficient), and high solubility in water, it is anticipated that aniline would be present in the environment predominately in water (greater than 99 percent) under steady-state conditions (Government of Canada 1994).

If released into water, environmental fate processes may result in rapid removal from the water column. Major processes include biodegradation, photodegradation and, to some extent, adsorption to sediment and humic materials (Howard 1989).

Aniline is a benchmark chemical for aerobic biodegradability tests and there are abundant data on its biodegradation (Howard 1989; Lyons *et al.* 1984 and 1985; Subba-Rao *et al.* 1982). Complete aerobic biodegradation may take anywhere from a few days to many weeks. Degradation is frequently 90-100 percent in laboratory tests with activated sludge or sewage seed lasting from 3 to 28 days. Biodegradation rates most appropriate for natural systems include a half-life of 6 days in a eutrophic pond and 75-95 percent mineralization in 21 days in an oligotrophic lake.

Aniline is highly susceptible to photolysis by sunlight (Meallier 1969). Humic acids photosensitize the reaction of aniline in water, as does the presence of algae (Zepp and Schlotzhauer 1983; Zepp *et al.* 1981). The estimated half-life for photodegradation in surface water ranges from hours to weeks (Howard 1989).

Using a measured Henry's Law constant of  $1.2 \times 10^{-4}$  atm-m<sup>3</sup>/mole (Yoshida *et al.* 1983), the estimated half-life for evaporation of aniline from a model river (1 m deep with a 1 m/sec current and a 3 m/sec wind) is 12 days (Thomas 1982).

Based on a log Kow of 0.9 (Table 1) and reported bioconcentration factors (BCF) for fish of 6 and 20 (Lu and Metcalf 1975; Dauble *et al.* 1984), bioconcentration of aniline is not expected to be an important environmental fate process (Hawker and Connell 1988; see Section 3.0).

If released on land, aniline will exhibit low to moderate sorption to soils and may leach into ground water (Howard 1989). Aniline is readily biodegraded under aerobic conditions and has been reported in ground water associated with wastes.

If released into the atmosphere, aniline will degrade primarily by photochemical oxidation with an estimated half-life of 3.3 hours (Howard 1989).

Aniline has been detected in effluents from municipalities and industries, ground water, soil, air and fresh fruits and vegetables in North America (Howard 1989). No data were found concerning concentrations of aniline in air, soil, sediment, biota in Ontario. Dischargers to Ontario surface waters did not monitor for aniline under the MISA program since there was no routine analytical detection limit available. Aniline was however recently detected in surface water and ground water at Elmira. The concentrations found in the Canagagigue Creek at Elmira ranged from non-detectable to 0.017 mg/L (the geometric mean was approximately 0.001 mg/L)(CRA 1994). The concentrations found in ground water ranged from non-detectable (detection limit of 0.0001 mg/L) to 135 mg/L.

In summary, aniline is not expected to persist in the environment based on its relatively short half-life (i.e., up to a few weeks) in water, soil and air. In surface water, aniline will undergo rapid photodegradation and biodegradation.

## 2.0 AQUATIC TOXICITY

Criteria used for classifying available toxicity data as either primary or secondary information are described in "Ontario's Water Quality Objective Development Process" (Environment Ontario 1992). In general, primary toxicity studies involve acceptable test procedures, conditions, and controls, measured toxicant concentrations, and flow through or renewal exposure conditions. Secondary toxicity studies usually involve unmeasured toxicant concentrations, static bioassay conditions, and unsatisfactory reporting of experimental data. Generally, acute toxicity studies involve test durations of 96 hours or less for vertebrates or 48 hours or less for invertebrates. Chronic toxicity data studies include complete life cycle tests and partial life cycle tests involving early life stages.

### 2.1 ACUTE TOXICITY

#### 2.1.1 Vertebrates

Primary acute toxicity studies were available for rainbow trout (Oncorhynchus mykiss), fathead minnow (Pimephales promelas), goldfish (Carassius auratus), white sucker (Catostomus commersoni) and bluegill sunfish (Lepomis macrochirus) (Table 2). A 7d-LC50 or median lethal concentration of 8.2 mg/L was reported for rainbow trout (Abram and Sims 1982). 96h-LC50 values for fish ranged from 10.6 mg/L (rainbow trout) to 187 mg/L (goldfish) (Abram and Sims 1982; Holcombe et al. 1987; Geiger et al. 1990; Hermens et al. 1990; Hodson et al. 1984; Brooke et al. 1984; Bradbury et al. 1989). 96h-LC50 values for fathead minnows ranged from 68.6 mg/L to 134 mg/L (Marchini et al. 1992; Holcombe et al. 1987). Holcombe et al. (1987) also reported 96h-LC50 values of 78.4 mg/L for white sucker and 49 mg/L for bluegill sunfish.

Primary information was also available for clawed frog (Table 2). Davis et al. (1981) exposed various early life stages of clawed frog to aniline. The free swimming larvae were the most sensitive life stage tested and exhibited a 96h-LC50 of 150 mg/L. A 24h-EC50 of 360 mg/L for induced abnormalities in mid-blastula embryos was also reported. In general, tailbud embryos were less sensitive to aniline toxicity than mid-blastula embryos or free swimming larvae.

In studies considered as secondary information, 96h-LC50s for fathead minnow ranged from 32 mg/L to 75.5 mg/L (Ewell et al. 1986; Geiger et al. 1990). In other fish studies, 48h-LC50 values ranged from 43 to 168 mg/L. Species tested were rainbow trout, fathead minnows, guppy (Poecilia reticulata), medaka (Oryzias latipes), goldfish, golden orfe (Leuciscus idus), carp, and killifish (Juhnke and Lüdemann 1978; Tonogai et al. 1982 and 1983; Slooff et al. 1983; Yoshioka and Ose 1993). In addition, Slooff et al. (1983) reported 48h-LC50 values of 440 and 560 mg/L for aquatic stages of salamanders (Ambystoma mexicanum) and clawed frog (Xenopus laevis), respectively.

In a physiological study of rainbow trout exposed to a lethal concentration of aniline (68.84 mg/L), the mean survival time was  $3.4 \pm 1.5$  hours (Bradbury et al., 1989). Visible signs of intoxication were exhibited shortly after toxicant exposure. Within minutes of exposure, the cough frequency increased. Within approximately 20 minutes of exposure, the fish exhibited tremors that originated in the head and moved posteriorly to the tail. In most instances these tremors were initiated with a cough. Within approximately 60 minutes, these tremors progressed to periods of whole-organism clonic seizures, which culminated in episodes where the tail was raised out of the water. In addition, aniline caused a steady decline in the ventilation volume and the total oxygen consumption of exposed fish (i.e., approximately 40 to 50 percent decreases were observed after 160 minutes of exposure). In summary,

aniline is considered to be a polar narcotic or type II narcotic. It was shown to induce a narcosis syndrome in rainbow trout characterized by a significant excitatory effect on the central nervous system followed by general depression and respiratory-cardiovascular collapse. The response exhibited by fish suggests that aniline was affecting the central nervous system, including the spinal cord and perhaps the peripheral nervous system.

### 2.1.2 Invertebrates

Primary toxicity information was limited to a 48h-EC50 of 0.25 mg/L for the immobilization of water flea (Daphnia magna) exposed to aniline in water (Holcombe *et al.* 1987). However, secondary information was available for a variety of aquatic invertebrates including water flea, flatworm, worms (Oligochaeta and Hirudinea), snail, aquatic sow bug (Isopoda), scud (Amphipoda), hydra (Hydrozoa) and insects (Insecta) (Table 2). The 48h-LC50 values ranged from 0.10 mg/L for Daphnia pulex to 800 mg/L for snail, Lymnaea stagnalis (Canton and Adema 1978; Slooff 1983; Gersich and Mayes 1986; Franco *et al.* 1984; Slooff *et al.* 1983). The 48h-LC50 of 64 mg/L for stonefly or plecoptera (Nemoura cinerea) was the lowest reported median lethal concentration for insects (Slooff 1983).

## 2.2 CHRONIC TOXICITY

### 2.2.1 Vertebrates

Primary chronic studies were available for fathead minnows, zebra fish (Brachydanio rerio), largemouth bass (Micropterus salmoides), channel catfish (Ictalurus punctatus), goldfish, and the clawed frog (Davis *et al.* 1981; Birge *et al.* 1979; Hall *et al.* 1984, 1989; Marchini *et al.* 1992; Van Leeuwen *et al.* 1990). Median lethal concentrations for fish ranged from 4.4 mg/L for early life stages of largemouth bass to 134.6 mg/L for adult fathead minnows (Table 2) (Birge *et al.* 1979; Hall *et al.* 1984, 1989). 120h-LC50s of 95 mg/L and 500 mg/L and a 120h-EC50 (abnormalities) of 91 mg/L were reported for early life stages of clawed frog (Davis *et al.* 1981).

Birge *et al.* (1979) exposed a number of fish species to aniline from the fertilized egg stage to 8 days post-hatch. The lowest LC50 values reported were 4.4 mg/L (8 days post-hatch), 5.0 mg/L (4 days post-hatch) and 4.7 mg/L (8 days post-hatch) for largemouth bass, channel catfish, and goldfish, respectively. Hermens *et al.* (1984) reported a 14 day LC50 of 126 mg/L for guppy (Poecilia reticulata).

### 2.2.2 Invertebrates

Gersich and Milazzo (1990) exposed Daphnia magna to aniline for 14 days. The lowest observed adverse effect concentration (LOAEC) was approximately 0.043 mg/L for significantly reduced growth, survival and reproduction as found in two tests ( $P \leq 0.05$ ). Average survival, total young per adult, brood size per adult and dry weight per adult (mg) were: 100±0%, 85±14, 27±3 and 0.576±0.133 for control animals (test I); 15±36%, 59±32, 24±8, and 0.235±0.128 for exposed animals at 0.0430 mg/L (test I); 100±0%, 83±15, 27±4 and 0.487±0.11 for control animals (test II); and 10±31%, 13±1, 13±1, and 0.365±0 for exposed animals at 0.0432 mg/L (test II), respectively. No observed effect concentrations (NOEC) of 0.0208 mg/L (test I) and 0.0102 mg/L (test II) were found.

At 0.0218 mg/L (test II), mean survival was reduced by 15 percent, although growth and reproduction were not significantly affected. No survival of daphnids was found at 0.0718 mg/L (test I) or 0.0774 mg/L (test II).

In an earlier study, Gersich and Milazzo (1988) exposed Daphnia magna to aniline for 21 days. The lowest observed effect level (LOEL) was 0.0467 mg/L for significantly reduced reproduction and survival of Daphnia magna ( $P \leq 0.05$ ). Average survival, total young per adult, and brood size per adult were  $100 \pm 0\%$ ,  $90 \pm 13$ , and  $24 \pm 2$  for control animals and  $50 \pm 51\%$ ,  $58 \pm 26$ , and  $20 \pm 4$  for exposed animals at 0.0467 mg/L, respectively. At 0.09 mg/L, mean survival, total young per adult, and brood size per adult for exposed animals were lowered to  $25 \pm 44\%$ ,  $3 \pm 4$  and  $3 \pm 4$ , respectively. No survival of daphnids was found at 0.169 mg/L. The no observed effect concentration (NOEC) for survival, reproduction and growth was 0.0246 mg/L.

Secondary studies were also available for other invertebrate species (Table 2). 96h-LC50s of 31.6 mg/L and 100 mg/L were reported for the flatworm (Dugesia tigrina) and snail (Helisoma trivolvis), respectively (Ewell et al. 1986).

### 2.2.3 Other Organisms (Plants, Bacteria, Protozoa)

Population growth of algae, Selenastrum capricornutum, was reduced by approximately 40% after four days of exposure to aniline at 5 mg/L (Table 2)(Adams et al. 1985). Also, the growth of Chlorella vulgaris was significantly reduced by approximately 20% after 14 days of exposure to 184 mg/L (Ammann and Terry 1985). Slooff et al. (1983) reported a 96h-NOEC of 10 mg/L for S. capricornutum and Calimari et al. (1980) reported a 96h-EC50 (growth) of 19 mg/L for S. capricornutum.

24h-EC50s for significantly reduced cell counts or population growth of protozoa (Tetrahymena pyriformis) ranged from 60.1 to 190 mg/L (Arnold et al. 1990; Yoshioka et al. 1985). In studies considered as ancillary or tertiary information, toxicity threshold concentrations for bacteria and protozoa ranged from 0.16 mg/L for Microcystis aeruginosa to 250 mg/L for Chilomonas paramecium (Slooff et al. 1983).

## 2.3 SUMMARY OF TOXICITY DATA

Primary acute studies were available for rainbow trout, fathead minnow, goldfish, white sucker, bluegill sunfish, clawed frog, and water flea (Daphnia magna). Secondary studies were available for a large number of fish and invertebrate species as well as two species of amphibians. Median lethal concentrations ranged from 8.2 mg/L to 1620 mg/L for vertebrates and from 0.10 mg/L to 800 mg/L for invertebrates.

Primary chronic studies were available for zebra fish, fathead minnow, largemouth bass, channel catfish, goldfish, and clawed frog. Secondary studies or ancillary information were found for guppy and several invertebrate, protozoa, and algal species. Median lethal concentrations ranged from 4.4 mg/L to 866 mg/L for fish and amphibians. Effect concentrations ranged from 0.0218 mg/L to 100 mg/L for invertebrates. Effect concentrations reported for algae and other microorganisms ranged from 5 mg/L to 190 mg/L.



Daphnia magna was the most sensitive species tested and exhibited the lowest observed adverse effect concentration (LOAEC) of 0.043 mg/L for significantly reduced growth, survival and reproduction.

### 3.0 BIOACCUMULATION

Dauble et al. (1984) studied the uptake of radiolabelled ( $^{14}\text{C}$ ) aniline by rainbow trout. The fish were exposed to approximately 0.032 mg/L of aniline for up to 96 hours. Whole fish tissue reached a maximum radiocarbon level at 72 hours. The bioconcentration factor (BCF) for aniline and metabolites in fish was found to be 20. When exposed animals were placed in aniline-free water, the body burden of radioactivity decreased by 50% after 24 hours of depuration.

Similarly, Dauble et al. (1984, 1986) studied the uptake of radiolabelled aniline by adult Daphnia magna exposed to a concentration of approximately 0.5 mg/L. Based on the 24 hour exposure period, the bioconcentration factor for aniline and metabolites in Daphnia magna was 74. Based on the 24 hour depuration period, the half-life for removal of radioactivity in Daphnia magna was estimated to be 26.5 hours.

In an aquatic microcosm study, a 24h-BCF of 6 was found for aniline and metabolites in mosquito fish (Gambusia affinis) (Lu and Metcalf 1975). Similarly, Freitag et al. (1985) reported BCF values of less than 10 for fish (Leuciscus idus melanotus) and algae (Chlorella fusca) and Geyer et al. (1984) reported a 24h-BCF of 4 for Chlorella fusca.

Hardy et al. (1985) investigated the uptake of  $^{14}\text{C}$ -aniline at 0.48 and 1.26 mg/L by unicellular algae, Scenedesmus quadricauda. Based on radioactivity, algae bioconcentrated aniline by a factor of 91 during a 24 hour period.

In summary, the available BCF data for aniline in three species of fish, Daphnia magna, and algae demonstrate that aniline does not undergo significant bioaccumulation in aquatic biota.

### 4.0 MUTAGENICITY

The genotoxic effects of aniline have been recently reviewed (Government of Canada 1994; IRIS 1992; GENETOX 1992; U.S. EPA 1985). In summary, test results for aniline have been generally negative in a variety of in vitro genotoxicity assays using bacterial or yeast systems both with and without metabolic activation. Aniline did not induce DNA damage or gene mutation in bacteria (Salmonella or E. coli strains). Also, it did not cause mitotic recombination or gene mutation in yeast (Saccharomyces) or mold (Aspergillus).

Aniline generally induced positive test results in a variety of genotoxicity assays using animal cells in vitro. In these assays positive results were obtained with and without metabolic activation. Aniline induced gene mutation in mouse L5178Y cells. This chemical also induced chromosomal aberrations or sister chromatid exchanges in mouse bone marrow, Chinese hamster ovary and lung fibroblasts. Two metabolites of aniline, 2-aminophenol and N-phenylhydroxylamine induced sister chromatid exchanges in human fibroblasts in vitro. With in vitro transformation assays (measuring conversion of precancerous to cancerous cells), aniline induced positive results with mouse BALB/C3T3, but was negative with Syrian hamster or RLV/FISHER rat embryo cells.

With in vivo assays, aniline induced positive results with tests for DNA damage in rats and mice and sister chromatid exchanges in mice. This chemical also induced micronuclei (chromosomal breaks) in rat and mouse bone marrow cells.

The scientific literature did not contain information on tests for mutagenic or genotoxic damage in aquatic plants and animals exposed to aniline. As a result, there is insufficient information available to develop a numerical criterion for the protection of aquatic life. Since in vitro and in vivo mammalian data suggest that aniline is genotoxic, aniline may have the potential for causing genotoxicity damage in aquatic organisms.

## 5.0 ODOUR AND TASTE

In a study of fish flesh tainting, 1 and 10 mg/L of aniline in water did not impair the flavour of rainbow trout (Shumway and Palensky 1973).

The lowest threshold odour concentration (TOC) reported for aniline in water was 2.0 mg/L (Baker 1963). Persson (1984) reported a TOC of 458 mg/L (geometric mean).

## 6.0 DERIVATION OF THE INTERIM PWQO

Since the toxicological database for aniline was limited, a Provincial Water Quality Objective could not be developed. Therefore, following standard procedures as outlined in Environment Ontario (1992), the process reverted to the derivation of an Interim Provincial Water Quality Objective for the protection of aquatic life.

Where Interim PWQOs are set to protect aquatic life, the objective is derived by dividing the lowest adverse effect concentration by an "uncertainty factor". The size of the uncertainty factor reflects the quality and quantity of data available and the potential of the material to bioaccumulate.

The Federal-Provincial Working Group on recreational water quality has not recommended limits for chemicals in recreational water for human exposure because of the lack of sufficient scientific information (Health and Welfare Canada 1992). Therefore, a recreational use water quality objective for the protection of human health is not recommended at this time.

Humans dermally exposed to aniline exhibited rapid absorption through the skin (U.S. EPA 1985). The apparent absorption rates of aniline after healthy volunteers immersed one hand in aqueous solutions of 1 or 2 percent aniline for periods of 30 or 60 minutes ranged from 0.15 to 1.38 mg/cm<sup>2</sup>/hour. About four times as much aniline was absorbed from the 2 percent solution as from the 1 percent solution and absorption rates tended to decrease with time. Since aniline is unlikely to be present in Ontario surface waters or may occur at much lower concentrations (i.e., less than 0.001 mg/L), this suggests that exposure through skin contact with water is likely insignificant.



## 6.1 CALCULATION OF THE FINAL UNCERTAINTY FACTOR

The selection of a baseline uncertainty factor depends on reported BCFs or octanol-water partition coefficients (Kow) (which are useful indicators of the bioaccumulation potential of a substance). As discussed earlier, BCF values for a variety of organisms ranged from 6 to 91. Chiou and Schmedding (1982) reported a log Kow of 0.9 for aniline. Therefore, a baseline uncertainty factor of 1000 was selected, since available BCF values were less than 1000 and the log Kow was less than 4 (Environment Ontario 1992; see Table 3).

The final uncertainty factor was calculated based on the following toxicity information:

The following data were used in the acute toxicity category:

- The 96h-LC50 of 77.9 mg/L for fathead minnows (Pimephales promelas) was considered as primary information (Holcombe et al. 1987).
- The 7d-LC50 of 8.2 mg/L for rainbow trout was considered as primary information (Abram and Sims 1982).
- The 96h-LC50 of 49 mg/L for bluegill sunfish was considered as primary information (Holcombe et al. 1987).
- The 48h-EC50 (immobilization) of 0.25 mg/L for Daphnia magna was considered as primary information (Holcombe et al. 1987).
- The 48h-LC50 of 64 mg/L for the plecopteran or stonefly, Nemoura cinerea, was considered as secondary information (Slooff 1983).

The following data were used in the chronic toxicity category:

- The 4d(post-hatch)-LC50 of 5.0 mg/L for early life stages of channel catfish was considered as primary information (Birge et al. 1979).
- The 8d(post-hatch)-LC50 of 4.4 mg/L for early life stages of largemouth bass was considered as primary information (Birge et al. 1979).
- The 8d(post-hatch)-LC50 of 4.7 mg/L for the hatching and survival of goldfish was considered as primary information (Birge et al. 1979).
- The 14d-LOAEC of 0.0430 mg/L for statistically significant reduced growth, survival and reproduction of Daphnia magna was considered as secondary information (Gersich and Milazzo 1990).
- The 96h-LC50 of 31.6 mg/L for Dugesia tigrina was considered as secondary information (Ewell et al. 1986).
- The 96h-EC40 of 5 mg/L for inhibition of growth of Selenastrum capricornutum was considered as secondary information (Adams et al. 1985).

Based on the above information and applying the appropriate calibration factors, a value of 20 was derived as the final uncertainty factor (Table 3).

## 6.2 CALCULATION OF THE INTERIM OBJECTIVE

The following interim objective was set as a single value independent of other water quality parameters such as temperature or water hardness. Birge *et al.* (1979) reported that water hardness exerted no appreciable effects on the toxicity of aniline.

The 14d-LOAEC of 0.0430 mg/L for significantly reduced growth, survival and reproduction of *Daphnia magna* was considered the lowest valid adverse effect concentration or critical value (Gersich and Milazzo 1990). This value divided by the final uncertainty factor of 20 produced a preliminary objective value of 0.002 mg/L (Table 3 and Figure 1).

Shumway and Palensky (1973) found that 10 mg/L of aniline in water did not impair the taste of rainbow trout flesh. Therefore, the preliminary objective value is expected to protect against any fish flesh tainting potential of aniline.

The lowest valid threshold odour concentration for aniline in water was found to be 2.0 mg/L (Baker 1963). This value multiplied by a safety factor of 0.5 produced an odour protection value of 1.0 mg/L.

Although aniline should be considered to be genotoxic, there was no information available to develop a numerical mutagenicity criterion for the protection of aquatic life. Data on the genotoxicity of aniline in fish, invertebrates, or plants was not found and this lack of information is an important data gap. Because aniline is genotoxic in mammalian systems, the possibility of its genotoxic hazard in aquatic organisms cannot be excluded.

Since the preliminary objective value of 0.002 mg/L, based on toxicity, is below the odour protection value and a reported concentration not impairing fish flavour, the recommended Interim Provincial Water Quality Objective for aniline is 0.002 mg/L.

## 7.0 RESEARCH NEEDS

A sensitive routine analytical method for measuring aniline in water needs to be developed.

Primary chronic toxicity studies involving a cold-water fish and an invertebrate are needed to fulfil the minimum data requirements for developing a Provincial Water Quality Objective. Information on the genotoxicity of aniline in fish, invertebrates, and aquatic plants is also needed.

## 8.0 AMBIENT WATER QUALITY CRITERIA OF OTHER AGENCIES

The Canadian Council of Ministers of the Environment developed a Canadian water quality guideline for aniline of 0.002 mg/L for the protection of aquatic life (CCME 1993). The Michigan Department of Natural Resources developed a guideline level of 0.004 mg/L (Aquatic Chronic Value).

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# TABLE 1: PHYSICAL-CHEMICAL PROPERTIES

CHEMICAL:  
ANILINE

CHEMICAL FORMULA:  
 $C_6H_7N$

CAS No:  
62-53-3

## PROPERTIES

MOLECULAR WEIGHT (MW): 93.12 g/mol Howard (1989)

MELTING POINT: -6.3°C Howard (1989)

BOILING POINT: 184-186°C Howard (1989)

PHYSICAL STATE AT STANDARD TEMPERATURE AND PRESSURE: liquid

DISSOCIATION CONSTANT (pKa OF CONJUGATE ACID): 4.6 Howard (1989)

DENSITY (D): 1.02 g/cm<sup>3</sup> Verschueren (1983)

MOLAR VOLUME (MW/D): 91.3 cm<sup>3</sup>/mol (calc.)

VAPOUR PRESSURE (Ps): 0.489 mmHg at 25°C Howard (1989)

WATER SOLUBILITY (Cs): 34,000 mg/L Verschueren (1983) 36,070 mg/L at 25°C Howard (1989)

HENRY'S LAW CONSTANT:  $1.76 \times 10^{-6}$  atm-m<sup>3</sup>/mol (Ps/Cs)  $1.2 \times 10^{-4}$  atm-m<sup>3</sup>/mol Yoshida et al. (1983)

## PERSISTENCE

SURFACE WATER HALF LIFE: hours to weeks Howard (1989)

AQUATIC FATE: photodegradation, biodegradation Howard (1989)

BREAKDOWN PRODUCTS:

## OCTANOL-WATER PARTITION COEFFICIENT (Kow)

RANGE OF AVAILABLE log Kow VALUES: 0.9 Chiou and Schmedding (1982)

FINAL CHOSEN log Kow VALUE: 0.9

## BASELINE UNCERTAINTY FACTOR FOR GUIDELINE DEVELOPMENT

If Log Kow < 4.00, use 1000

If Log Kow ≥ 4.00, use 10000

BASELINE UNCERTAINTY FACTOR: 1000

TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
ACUTE TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY (2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP. (°C)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)				
<b>VERTEBRATES</b> <i>Rainbow trout</i> <i>Oncorhynchus mykiss</i>	2.9±0.3 cm	7d-LC50	7.4	15±1	10.2		250	8.2	FM	PA	Abram & Sims, 1992
	0.25±0.06 g	96h-LC50	7.4	15±1				10.6	FM	PA	Abram & Sims, 1982
		48h-LC50	7.4	15±1				28.3	FM	PA	Abram & Sims, 1982
		24h-LC50	7.4	15±1				30.5	FM	PA	Abram & Sims, 1982
		12h-LC50	7.4	15±1				46.0	FM	PA	Abram & Sims, 1982
	4.6-6.4 cm (1.2-3.8 g)	96h-LC50	7.60-8.19	14.1-16.5	5.6-9.4	86		36.2	FM	PA	Hodson et al., 1984
	30-120 g juvenile	96-h LC50	7.17±0.1	10.5±0.3	8.5±1.4		46.2±1.1	33.5	FM	PA	Hermens et al., 1984
		96h-LC50 (estimated range)						20.4-23.7	RU	SA	Douglas et al., 1986
		96h-LC50 (estimated range)						20.7-24.7	SU	SA	Douglas et al., 1986
	5-8 wks old	48h-LC50	7.71±0.1	15				43	SU	SA	Slooff et al., 1983
	600-1000 g	24h-LC100	7.4	11-11.5	10.5-11	41.8±5.8	43.3±3.3	68.8±1.97	FM	PA	Bradbury et al., 1989
	0.9 g	96h-LC50	7.4	17.2±0.5	8.7±1.1	43	44.7	40.5	FM	PA	Holcombe et al., 1987
		96-h LC50	variable	15	>90% sat		320	41	SM	PA	Calamari et al., 1980
		96-h LC50			>90% sat		20	20	SM	PA	Calamari et al., 1980
<i>Fathead minnow</i> <i>Pimephales promelas</i>	33 days old 2.25±0.17 cm 0.159±0.04 g	96h-LC50	7.58±0.1	26.1±0.6	6.0±0.39	41.0	47.0	134	FM	PA	Brooke et al., 1984
	0.2-0.5 g	96h-LC50	7.4	20±1		93	130	32	SU	SA	Ewell et al., 1986
	3-4 wks old	48h-LC50		20				65	SU	SA	Slooff et al., 1983
	0.3 g	96h-LC50	7.4±0.2	17.2±0.5	8.7±1.1	43	44.7	77.9	FM	PA	Holcombe et al., 1987
	42-46 days old	96h-LC50		17.2	9.1±0.47	64.4±31	44.1±0.3	75.5	FM	SA	Geiger et al., 1990
	30 days old	96h-LC50	7.5±0.05	24.8±0.5	6.5±0.25	70.9±34	45.7±0.2	114	FM	PA	Geiger et al., 1990
		96h-EC50 (behav.)	7.5±0.05	24.8±0.5	6.5±0.25	70.9±34	45.7±0.2	112	FM	PA	Geiger et al., 1990
	Larvae <24h	96h-LC50						68.6	FM	PA	Marchini et al., 1992

KEY (1)  
TLm = Median Tolerance Limit  
LC = Lethal Concentration  
IC = Immobilization Concentration  
EC = Effects Concentration

KEY (2)  
S = Static  
F = Flowthrough  
U = Unmeasured Toxicant Concentration  
M = Measured Toxicant Concentration  
R = Renewed Static

KEY (3)  
P = Primary  
S = Secondary  
T = Tertiary  
A = Acute Toxicity  
C = Chronic Toxicity

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ACUTE TOXICITY DATA

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			pH	TEMP. (°C)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)				
Guppy <i>Poecilia reticulata</i>	3-4 wks old	48h-LC50		24				100	SU	SA	Slooff et al., 1983
Medaka <i>Oryzias latipes</i>	4-5 wks old 2 cm 2 cm 0.25 g	48h-LC50 48h-LC50 24h-TLm 48h-TLm 96h-LC50	7.2   7.8-8.3	20±1 24 25 25 25±2			40   110	168 165 74 48 21.5	RM SU SU SU SU	SA SA SA SA SA	Yoshioka and Ose, 1993 Slooff et al., 1983 Tonogai et al., 1982 Tonogai et al., 1982 Tadokorn & Maeda, 1988
Goldfish <i>Carassius auratus</i>	4.4 g 5 cm; 2.5 g	96h-LC50 48h-LC50	7.4 6-7	17.2±0.5 15	8.7±1.1 8	43	44.7 NA	187 104.0	FM FM	PA SA	Holcombe et al., 1987 Tonogai et al., 1983
White Sucker <i>Catostomus commersoni</i>	2.6 g	96h-LC50	7.4	17.2±0.5	8.7±1.1	43	44.7	78.4	FM	PA	Holcombe et al., 1987
Bluegill sunfish <i>Lepomis macrochirus</i>	1.1 g	96h-LC50	7.4	17.2±0.5	8.7±1.1	43	44.7	49	FM	PA	Holcombe et al., 1987
Golden Orfe <i>Leuciscus idus</i>	5-7 cm	48h-LC50 48h-LC50 48h-LC50		20				61 65 49	SU SU SU	SA SA SA	Juhnke & Ludemann, 1978 Juhnke & Ludemann, 1978 Juhnke & Ludemann, 1978
Carp <i>Cyprinus carpio</i>	10 cm; 16.5 g	48h-LC50	6-7	15	8			126.5	FM	SA	Tonogai et al., 1983
Killifish <i>Fundulus sp.</i>	3 cm; 0.3 g	48h-LC50 48h-LC50	6-7	15	8			113.0 115.0	SM FM	SA SA	Tonogai et al., 1983 Tonogai et al., 1983

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LC = Lethal Concentration  
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EC = Effects Concentration

KEY (2)  
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TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
ACUTE TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY(2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP. (°c)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)				
Salamander <i>Ambystoma mexicanum</i>	3-4 wk	48h-LC50		20				440	SU	SA	Slooff et al., 1983
Clawed frogs <i>Xenopus laevis</i>	Grp I (mid blastula embryos)	24h-LC50		20		95.5	101	1400	SM	PA	Davis et al., 1981
		48h-LC50		20		95.5	101	660	SM	PA	Davis et al., 1981
		72h-LC50		20		95.5	101	490	SM	PA	Davis et al., 1981
		96h-LC50		20		95.5	101	550	SM	PA	Davis et al., 1981
	Grp II (Tail bud embryos)	24h-LC50		20		95.5	101	1620	SM	PA	Davis et al., 1981
		48h-LC50		20		95.5	101	1350	SM	PA	Davis et al., 1981
		72h-LC50		20		95.5	101	1150	SM	PA	Davis et al., 1981
		96h-LC50		20		95.5	101	940	SM	PA	Davis et al., 1981
	Grp III (free swimming larvae)	48h-LC50		20		95.5	101	1400	SM	PA	Davis et al., 1981
		72h-LC50		20		95.5	101	540	SM	PA	Davis et al., 1981
		96h-LC50		20		95.5	101	150	SM	PA	Davis et al., 1981
	Grp I (mid blastula embryos)	24h-EC50 (abnormal.)		20		95.5	101	360	SM	PA	Davis et al., 1981
		48h-EC50 (abnormal.)		20		95.5	101	560	SM	PA	Davis et al., 1981
		72h-EC50 (abnormal.)		20		95.5	101	460	SM	PA	Davis et al., 1981
		96h-EC50 (abnormal.)		20		95.5	101	370	SM	PA	Davis et al., 1981
	3-4 wk	48h-LC50		20				560	SU	SA	Slooff et al., 1983

KEY (1)  
TLm = Median Tolerance Limit  
LC = Lethal Concentration  
IC = Immobilization Concentration  
EC = Effects Concentration

KEY (2)  
S = Static  
F = Flowthrough  
U = Unmeasured Toxicant Concentration  
M = Measured Toxicant Concentration  
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KEY (3)  
P = Primary  
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T = Tertiary  
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ACUTE TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY(2)	DATA QUALITY KEY (3)	REFERENCES	
			pH	TEMP. (°c)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)					
<u>INVERTEBRATES</u>												
Water flea <i>Daphnia magna</i>	<1 day old	48h-LC50						0.63	SU	SA	Canton & Adema, 1978	
		48h-LC50						0.55	SU	SA	Canton & Adema, 1978	
		48h-LC50						0.66	SU	SA	Canton & Adema, 1978	
		48h-LC50						0.68	SU	SA	Canton & Adema, 1978	
		48h-LC50						0.36	SU	SA	Canton & Adema, 1978	
	<24h old	48h-LC50	7.7-7.9	20±1				0.35	SU	SA	Canton & Adema, 1978	
		<24h old	48h-EC50	7.4	17.2±0.5	8.7±1.1	49±3.9	77±4.3	0.17	SU	SA	Gersich & Mayes, 1986
	<72h old	(immob.)				43	44.7	0.25	FM	PA	Holcombe et al., 1987	
		24h-IC50	7.8-8.2	20±1			200	45.3	SU	SA	Devillers et al., 1987	
	neonates	24-h EC50			20			2.4	0.9	SU	SA	Kuhn et al., 1989
		(immob.)					mmol/L		0.3	SU	SA	Kuhn et al., 1989
	<24 h old	48-h EC50										
(immob.)												
	<24 h old	24-h LC50	7.6-7.7	20-22	sat.		70	0.5	SU	SA	Bringmann and Kuhn, 1977a	
		24-h EC50	7.8-8.3	18-22			160-180	97.8	SU	SA	Tadokoro and Maeda, 1988	
		(immob.)						23	SU	SA	Calamari et al., 1980	
Water flea <i>Daphnia pulex</i>	<1 day old	48h-LC50						0.10	SU	SA	Canton & Adema, 1978	
Water flea <i>Daphnia cucullata</i>	11±1 days old	48h-LC50						0.69	SU	SA	Canton & Adema, 1978	
		48h-LC50						0.68	SU	SA	Canton & Adema, 1978	
Oligochaeta Tubificidae		48h-LC50		20±1				450	SU	SA	Slooff, 1983	
Hirudinea <i>Erpobdella octoculata</i>		48h-LC50		20±1				760	SU	SA	Slooff, 1983	
Snail <i>Lymnaea stagnalis</i>	3-4 wk	48h-LC50		20±1				800	SU	SA	Slooff, 1983	
Isopoda <i>Asellus aquaticus</i>		48h-LC50*		20±1				68	SU	SA	Slooff, 1983	

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TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
ACUTE TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY(2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP. (°C)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)				
Amphipoda <i>Gammarus pulex</i>		48h-LC50		20±1				112	SU	SA	Slooff, 1983
Flatworm <i>Dugesia lugubris</i>		48h-LC50		20±1				155	SU	SA	Slooff, 1983
Hydrazoa <i>Hydra oligactis</i>	budless	48h-LC50		20±1				406	SU	SA	Slooff, 1983
<u>INSECTA</u> Heteroptera <i>Corixa punctata</i>		48h-LC50		20±1				150	SU	SA	Slooff, 1983
Odonata <i>Ischnura elegans</i>		48h-LC50		20±1				235	SU	SA	Slooff, 1983
Plecoptera <i>Nemoura cinerea</i>		48h-LC50		20±1				64	SU	SA	Slooff, 1983
Ephemeroptera <i>Cloëon dipterum</i>		48h-LC50		20±1				220	SU	SA	Slooff, 1983
Diptera <i>Chironomus sp.</i>		48h-LC50		20±1				175	SU	SA	Slooff, 1983
Diptera <i>Chironomus tentans</i>	3rd-4th instar	48h-LC50	7.8	17±0.5		150		412.2	SU	SA	Franco et al., 1984
		48h-LC50	7.8	17±0.5		150		399.9	SU	SA	
Diptera <i>Einfeldia natchitochae</i>	3rd-4th instar	48h-LC50	7.8	17±0.5		150		442.5	SU	SA	Franco et al., 1984
		48h-LC50	7.8	17±0.5		150		427.9	SU	SA	
Diptera (mosquito) <i>Aedes aegypti</i>	3rd instar	48h-LC50		26				155	SU	SA	Slooff et al., 1983
Diptera (mosquito) <i>Culex pipiens</i>	3rd instar	48h-LC50		26				94	SU	SA	Slooff et al., 1983
Diptera <i>Tanytus neopunctipennis</i>	3rd-4th instar	48h-LC50	7.8	17±0.5		150		287.2	SU	SA	Franco et al., 1984
		48h-LC50	7.8	17±0.5		150		272.1	SU	SA	

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R = Renewed Static

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TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
ACUTE TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY(2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP. (°c)	D.O. (mg/L)	ALK. (mg/L)	HARD (mg/L)				
Diptera <i>Clinotanytus pinguis</i>	3rd-4th instar	48h-LC50	7.8	17±0.5		150		477.9	SU	SA	Franco et al., 1984
midge <i>Tanytarsus dissimilis</i>	3rd-4th instar	48h-LC50	7.4	17	7	43	44.7	>219	FM	T	Holcombe et al., 1987

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TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
CHRONIC TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY (2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP (°C)	D.O. (mg/L)	ALK (mg/L)	HARD (mg/L)				
<b>VERTEBRATES</b> Clawed frog <i>Xenopus laevis</i>	Grp I (mid blastula embryos)	120h-LC50		20		95.5	101	500	SM	PC	Davis et al., 1981
		120h-EC50 (abnormal.)		20		95.5	101	91	SM	PC	Davis et al., 1981
	Grp III (free swimming larvae)	120h-LC50		20		95.5	101	95	SM	PC	Davis et al., 1981
Guppy <i>Poecilia reticulata</i>		14d-LC50		22±1	>5		25	126	SU	SC	Hermens et al., 1984
Zebra fish <i>Brachydanio rerio</i>	embryo-larval	28d-LC50	7.4	24	5.1		210	39.0	RM	PC	Van Leeuwen et al., 1990
	8 cell stage	NOEL	8	25				93	SM	SC	Groth et al., 1993
	eggs	96h-LC50	8	25				866	SM	SC	Groth et al., 1993
Fathead minnow <i>Pimephales promelas</i>	30-35d	8d-LC50		25±2	6.2-8.2	38-44	43.3-45.5	134.6	FM	PC	Hall et al., 1984 & 1989
	Larvae <24h	7d-LC50		25±1				60.22	FM	PC	Marchini et al., 1992
	Larvae <24h	7d-NOEC (survival and growth)						15.7	FM	PC	Marchini et al., 1992
	Larvae <24h	7d-LOEC (survival and growth)						23.2	FM	PC	Marchini et al., 1992
Largemouth bass <i>Micropterus salmoides</i>	eggs through hatching	0d(ph)-LC50	7.84	19-24	9.9	66.7	53.3	47.3	FM	PC	Birge et al., 1979
		0d(ph)-LC50	7.78	19-24	10.1	65.3	197.5	43.2	FM	PC	Birge et al., 1979
		4d(ph)-LC50	7.84	19-24	9.9	66.7	53.3	10.5	FM	PC	Birge et al., 1979
		4d(ph)-LC50	7.78	19-24	10.1	65.3	197.7	8.4	FM	PC	Birge et al., 1979
		8d(ph)-LC50	7.84	19-24	9.9	66.7	53.3	5.2	FM	PC	Birge et al., 1979
		8d(ph)-LC50	7.78	19-24	10.1	65.3	197.7	4.4	FM	PC	Birge et al., 1979
Channel catfish <i>Ictalurus punctatus</i>	eggs through hatching	0d(ph)-LC50	7.84	28-29	9.9	66.7	53.3	5.6	FM	PC	Birge et al., 1979
		0d(ph)-LC50	7.78	28-29	10.1	65.3	197.5	7.4	FM	PC	Birge et al., 1979
		4d(ph)-LC50	7.84	28-29	9.9	66.7	53.3	5.0	FM	PC	Birge et al., 1979
		4d(ph)-LC50	7.78	28-29	10.1	65.3	197.7	7.0	FM	PC	Birge et al., 1979

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TABLE 2: AQUATIC TOXICITY DATA FOR ANILINE  
CHRONIC TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY (2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP (°C)	D.O. (mg/L)	ALK (mg/L)	HARD (mg/L)				
Goldfish <i>Carassius auratus</i>	eggs through hatching	0d(ph)-LC50 0d(ph)-LC50 4d(ph)-LC50 4d(ph)-LC50 8d(ph)-LC50 8d(ph)-LC50	7.84 7.78 7.84 7.78 7.84 7.78	19-24 19-24 19-24 19-24 19-24 19-24	9.9 10.1 9.9 10.1 9.9 10.1	66.7 65.3 66.7 65.3 66.7 65.3	53.3 197.5 53.3 197.7 53.3 197.7	10.2 10.0 5.6 4.8 5.5 4.7	FM FM FM FM FM FM	PC PC PC PC PC PC	Birge et al., 1979 Birge et al., 1979 Birge et al., 1979 Birge et al., 1979 Birge et al., 1979 Birge et al., 1979
<b>INVERTEBRATES</b>											
Water flea <i>Daphnia magna</i>	neonate (fed algae)	NOEC LOEL (reprod.)  14d NOEC 14d NOEC 14d LOEC (15% mortality) 14d LOAEC (growth, surv. & reprod.) 14d LOAEC (growth, surv. & reprod.)	7.8-8.3  8.0-8.2	20±2  23-24.5	  8.2-9.2	  49±3.9	160-190  170	0.050 0.100  .0208 .0102 .0218 .0432 .0430	FM  RM RM RM RM	SC  SC SC SC SC	Tadokora and Maeda, 1988  Gersich and Milazzo, 1990 Gersich and Milazzo, 1990 Gersich and Milazzo, 1990 Gersich and Milazzo, 1990 Gersich and Milazzo, 1990
	neonate 1st-2nd instar	96h-LC50 21d-LOEL (reproduction and survival)	6.5-8.5 7.8-8.1	20 19-21	>60% sat.	49±3.9	130 170	0.21 0.0467	SU RM	SC SC	Ewell et al., 1986 Gersich & Milazzo, 1988
	1st-2nd instar	21d-EC (reproduction and survival)	7.8-8.1	19-21		49±3.9	170	0.090	RM	SC	Gersich & Milazzo, 1988
	1st-2nd instar	21d-EC100 (reproduction and survival)	7.8-8.1	19-21		49±3.9	170	0.169	RM	SC	Gersich & Milazzo, 1988
	1st-2nd instar	96h-LC50	7.4	20±1		93	130	0.21	SU	SC	Ewell et al., 1986
Oligochaeta <i>Lumbriculus variegatus</i>	0.006g	96h-LC50	7.4	20±1		93	130	>100	SU	T	Ewell et al., 1986
Snail <i>Helisoma trivolvis</i>	0.180 g	96h-LC50	6.5-8.5	20±1	>60% sat.		130	100	SU	SC	Ewell et al., 1986

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CHRONIC TOXICITY DATA

SPECIES	LIFE STAGE	RESPONSE KEY (1)	TEST CONDITIONS					EFFECT CONC. (mg/L)	DATA CODES KEY (2)	DATA QUALITY KEY (3)	REFERENCES
			pH	TEMP (°C)	D.O. (mg/L)	ALK (mg/L)	HARD (mg/L)				
Flatworm <i>Dugesia tigrina</i>	0.006 g	96h-LC50	6.5-8.5	20±1	>60% sat.		130	31.6	SU	SC	Ewell et al., 1986
Isopoda <i>Asellus intermedius</i>	0.012 g	96h-LC50	7.4	20±1		93	130	>100	SU	T	Ewell et al., 1986
Amphipoda <i>Gammarus fasciatus</i>	0.0078 g	96h-LC50	7.4	20±1		93	130	>100	SU	T	Ewell et al., 1986
<b>OTHER ORGANISMS</b>											
<b>ALGAE</b>											
<i>Selenastrum capricornutum</i>		96h-EC40 (growth inhibition)		22				5	SU	SC	Adams et al., 1985
	log phase	96h-NOEC		26				10	SU	T	Slooff et al., 1983
	log phase	96h-EC50 (growth)						19	SM	SC	Calamari et al., 1980
<i>Chlorella pyrenoidosa</i>	log phase	48h-NOEC						11	SU	T	Slooff et al., 1983
<i>Chlorella vulgaris</i>		14d-EC20 (decrease in growth)						184	SU	SC	Ammann and Terry, 1985
	log phase	96-h EC50	7.8-8.3	20±2			160-190	58	SU	SC	Tadokora and Maeda, 1988
<i>Scenedesmus pannonicus</i>		192h-cell (multipl. inhibition test toxicity threshold)		27				8	SU	T	Slooff et al., 1983
<b>BACTERIA</b>											
<i>Microcystis aeruginosa</i>		192h-NOEC toxicity threshold		27				0.16	SU	T	Slooff et al., 1983
<i>Pseudomonas putida</i>		6h-NOEC toxicity threshold		25				130	SU	T	Slooff et al., 1983

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			pH	TEMP (°C)	D.O. (mg/L)	ALK (mg/L)	HARD (mg/L)				
<b>PROTOZOA</b>											
<i>Chilomonas paramecium</i>		48h-NOEC toxicity threshold		20				250	SU	T	Slooff et al., 1983
<i>Uronema parudczii</i>		20h-NOEC toxicity threshold		25				90	SU	T	Slooff et al., 1983
<i>Entosiphon sulcatum</i>		72h-NOEC toxicity threshold		25				24	SU	T	Slooff et al., 1983
<i>Tetrahymena pyriformis</i>	log phase 3-3.5d old	24h-EC50 (cell count)		30				190	SU	SC	Yoshioka et al., 1985
		24h-EC50 (culture growth)		30				60.1	SU	SC	Arnold et al., 1990
		72-h EC50 (growth)		28				154	SU	SC	Schultz and Allison, 1979
		24h-LC100 24h-EC50		30				2001 185.84	SM SM	T SC	Schultz et al., 1978 Yoshioka et al., 1985

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## Table 3: UNCERTAINTY FACTOR WORKSHEET

CHEMICAL:	CAS No.	CONCENTRATION UNITS
ANILINE	62-53-3	mg/L

Test Conditions		Species (life stage)	Toxicity End Point	Effect conc.	Data Codes <sup>1</sup>	Data Type <sup>2</sup>	Calibration Factor	Reference
ACUTE	VERTEBRATE	Fathead minnow 0.3 g	96h-LC50	77.9	F/M	1°	0.8	Holcombe et al. 1987
		Rainbow trout	7d-LC50	8.2	F/M	1°	0.8	Abram and Sims 1982
		Bluegill sunfish 1.1g	96h-LC50	49	F/M	1°	0.8	Holcombe et al. 1987
	INVERT.	<i>Daphnia magna</i> <24h old	48h-EC50 (immob.)	0.25	F/M	1°	0.8	Holcombe et al. 1987
		<i>Nemoura cinerea</i> stonefly	48h-LC50	64	S/U	2°	0.9	Slooff 1983

CHRONIC	VERTEBRATE	Channel catfish Early Life Stage	4d(posthatch) -LC50	5.0	F/M	1°	0.5	Birge et al. 1979
		Largemouth bass Early Life Stage	8d(posthatch) -LC50	4.4	F/M	1°	0.5	Birge et al. 1979
		Goldfish Early Life Stage	8d(posthatch) -LC50	4.7	F/M	1°	0.5	Birge et al. 1979
	INVERT.	<i>Daphnia magna</i>	14d-LOAEC (gr.,sur.,rep.)	0.0430	R/M	2°	0.7	Gersich & Milazzo 1990
		<i>Dugesia tigrina</i>	96h-LC50	31.6	S/U	2°	0.7	Ewell et al. 1986
	PLANT	<i>S. capricornutum</i>	96h-EC40 (growth)	5	S/U	2°	0.9	Adams et al. 1985

### CALCULATION OF FINAL UNCERTAINTY FACTOR:

Since Log Kow < 4.00, The Baseline Uncertainty Factor = 1000

Baseline Uncertainty Factor X Calibration Factors ( maximum number = 11 )

$$1000 \times 0.8 \times 0.8 \times 0.8 \times 0.8 \times 0.9 \times 0.5 \times 0.5 \times 0.5 \times 0.7 \times 0.7 \times 0.9$$

$$= 20 \quad \text{FINAL UNCERTAINTY FACTOR}$$

INTERIM PWQO = CRITICAL VALUE ÷ FINAL UNCERTAINTY FACTOR

$$= \frac{0.0430}{20} = 0.002 \text{ mg/L}$$

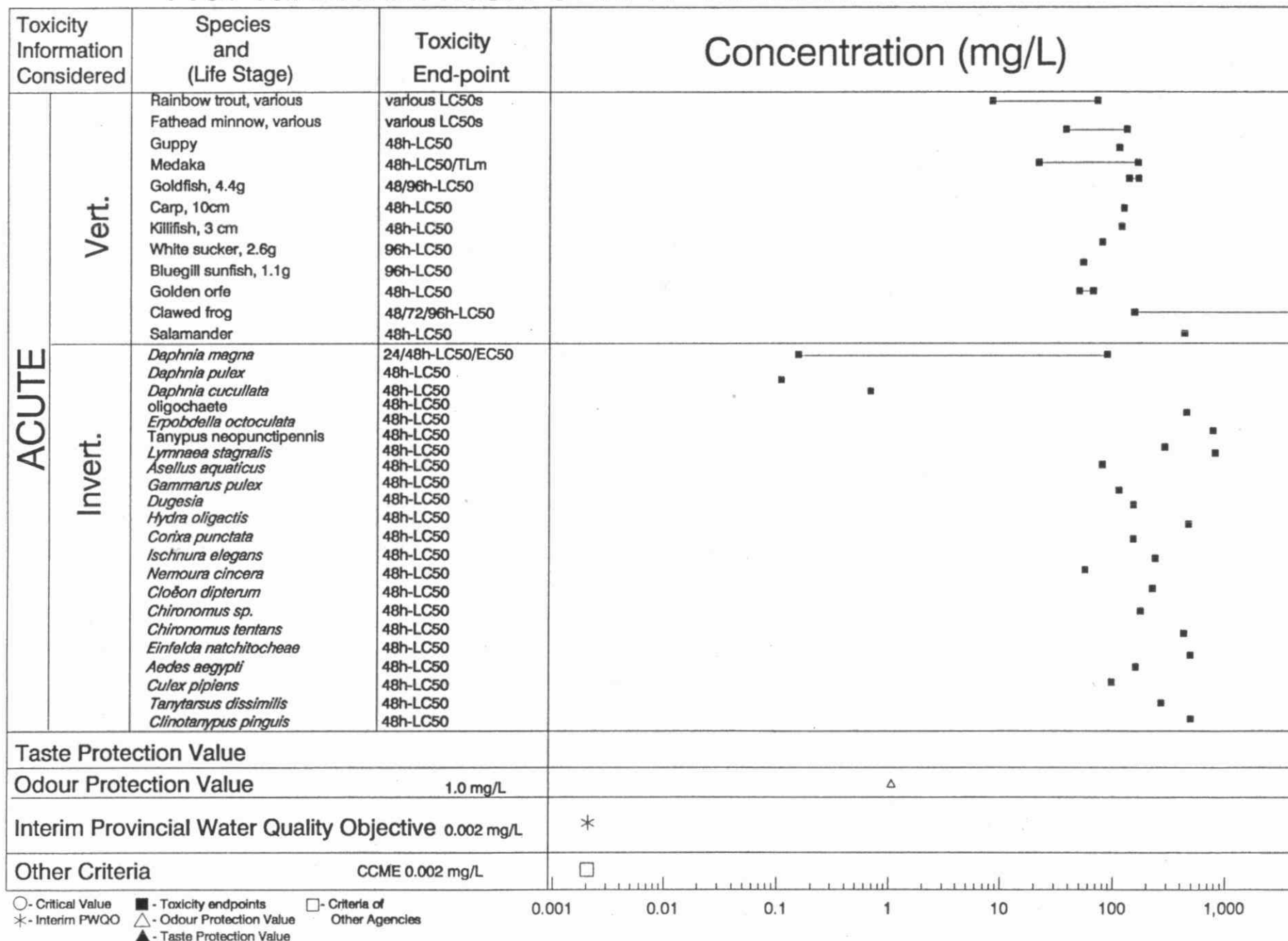
<sup>1</sup> Assign 2 DATA CODES, one from each of the following rows:

S = static      R = static/renewal      F = flowthrough  
U = unmeasured nominal conc.      M = measured conc.

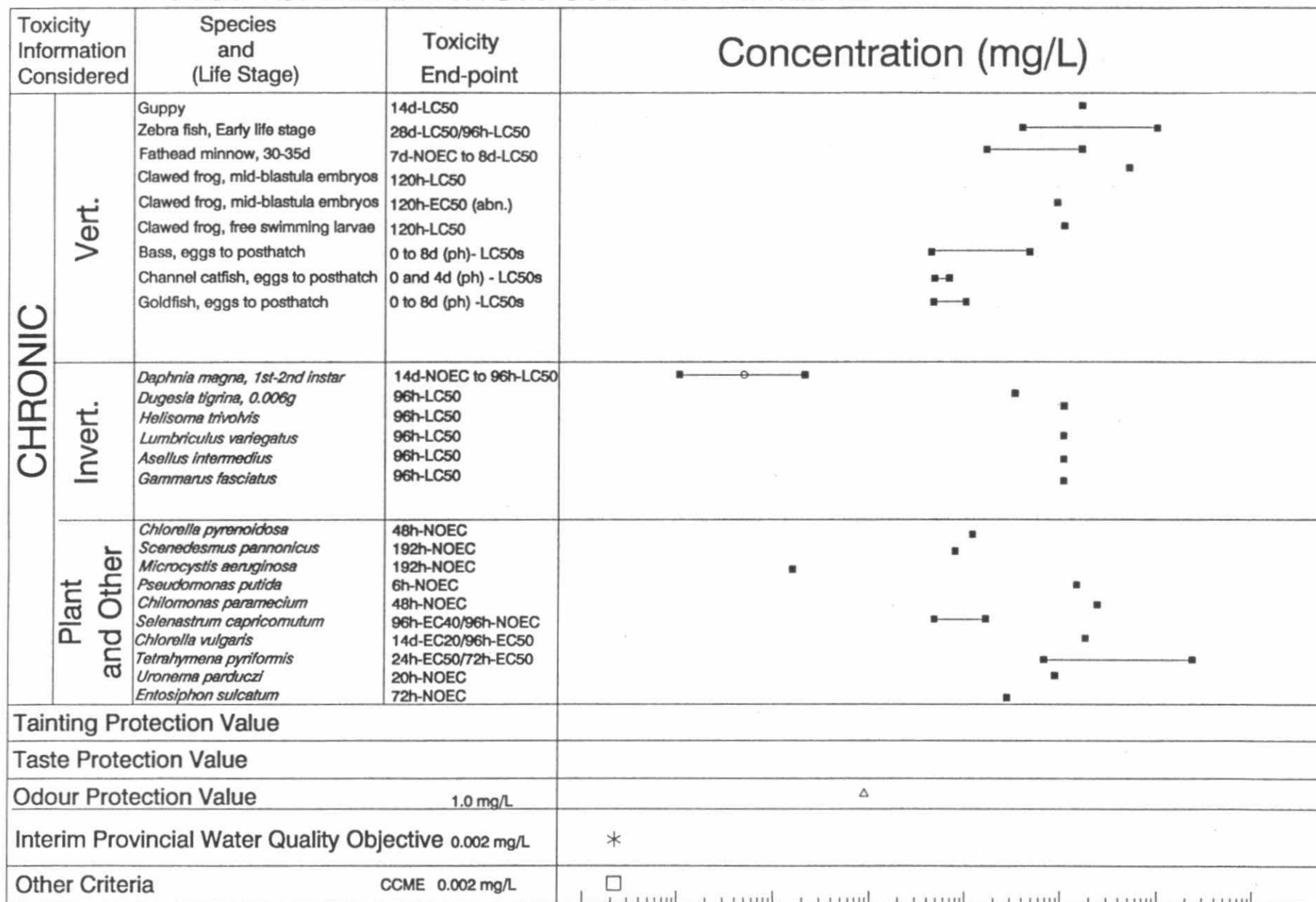
<sup>2</sup> DATA TYPE:

1° = Primary      2° = Secondary      3° = Simulated Data

# FIG. 1a: DERIVATION GRAPH - ANILINE



# FIG. 1b: DERIVATION GRAPH - ANILINE



○ - Critical Value  
 \* - Interim PWQO  
 ■ - Toxicity endpoints  
 △ - Odour Protection Value  
 ▲ - Taste Protection Value  
 □ - Criteria of Other Agencies

0.001 0.01 0.1 1 10 100 1,000 10,000